Long-Term Frequency Stability of Laser Cavity Solitons

Antonio Cutrona[1,2*], Maxwell Rowley[2], Abdelkrim Bendahmane[2], Vittorio Cecconi[1,2], Luke Peters[1,2], Luana Olivieri[1,2], Brent E. Little[3], Sai T. Chu[4], Salvatore Stivala[5], Roberto Morandotti[6], David J. Moss[7], Juan Sebastian Totero Gongora[1,2], Marco Peccianti[1,2], Alessia Pasquazi[1,2]*

[1]*Emergent Photonics Research Centre, Dept. of Physics, Loughborough University, Loughborough, LE11 3TU, England, UK*
[2]*Emergent Photonics (Epic) Lab, Dept. of Physics and Astronomy, University of Sussex, BN1 9QH, UK*
[3]*QXP Technologies, Shanglinyuan 1st RD, High-tech zone, Xi'an, China*
[4]*Department of Physics, City University of Hong Kong, Tat Chee Avenue, Hong Kong, China SAR*
[5]*Dipartimento di Ingegneria, Universita' degli Studi di Palermo, Viale delle Scienze, Palermo, Italy*
[6]*INRS-EMT, 1650 Boulevard Lionel-Boulet, Varennes, Québec, Canada J3X 1S2*
[7]*Optical Sciences Centre, Swinburne University of Technology, Hawthorn, VIC 3122, Australia*
[*]*Corresponding authors: a.cutrona@lboro.ac.uk and a.pasquazi@sussex.ac.uk*

Cavity Solitons are optical structures forming in nonlinear cavities when specific conditions of balance are verified [1]. In their temporal version, such solitary waves have been shown to improve the phase coherence properties of microcombs [2] (i.e., optical frequency combs in a microresonator).

Laser cavity-solitons [3–6] are a particular class of solitary waves obtained when light resonates in a microcavity nested into an amplifying main cavity. Recently, we demonstrated that these pulsed states are robust, efficient and self-starting [5,6] and characterising their frequency stability is of vital importance to enable their application in metrological contexts.

In this work, we show the long-term frequency stability of a laser cavity-solitons laser (Fig. 1 (a)). When the laser is properly configured, it is possible to obtain robust soliton states [5], whose output was collected at the Through output of the system (Fig. 1 (b)) to perform a long-term study. We have characterised the stability of the carrier comb line together with the repetition rate of the comb (Fig. 1 (c)). These two frequency quantities fully determine the comb from a metrological perspective.

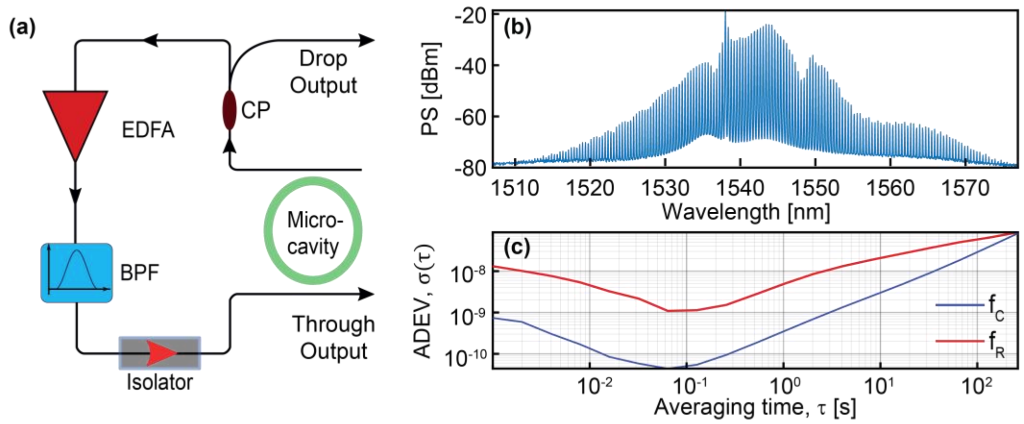

Fig. 1 Simplified experimental diagram of the laser cavity-soliton laser. A microresonator is nested into an amplifying fibre loop with an Er-doped fibre amplifier (EDFA), bandpass filter (BPF) and an isolator to ensure lasing in one direction. Solitary states can be simultaneously collected at the Through and Drop output, the last one being extracted through a coupler (CP). (b) Power spectrum (PS) at the Through output of the selected solitary state. (c) The Allan deviation (ADEV) of the carrier comb line (f_c) and repetition rate (f_R) frequencies for a 16-minute-long acquisition of stable solitary operation.

As we can see from Fig. 1 (c), we obtain Allan deviations at one second averaging time of 3.55×10^{-10} and 4.95×10^{-9}, respectively for the carrier and repetition rate. These results compare well with the literature of free running microcombs and fibre combs and demonstrate that our current implementation paves the way for a lock to metrological references.

References

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